INCOSE International Symposium 2012

Yes systems engineering, you are a discipline

Joseph Kasser

Derek Hitchins

Revision 1.0

Topics

- The undesirable situation
- Seven systems engineering camps
- Reconciling the camps
- SETR and SETA
- The systems engineering process
- Conclusions
- Simplifying the SEBoK
- The ‘T’ shaped systems engineer

The undesirable situation

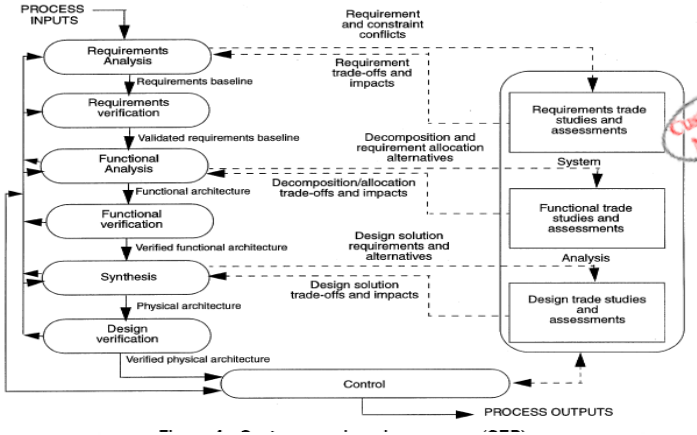
- The role of the systems engineer in the workplace depends on the situation.
- The role of the systems engineer has evolved over time
  - it is different in practically every organisation
  - has various degrees of overlap with the roles of project managers and personnel in other disciplines.
- Definitions and descriptions of systems engineering comprise different interpretations of the broad raft of activities that systems engineers might undertake according to their role in the workplace.
- Myths and defects abound unquestioned
- The problem is to convert the undesirable situation into a desirable situation
  - A common consensus on a GUTSE (Friedman, 2006)

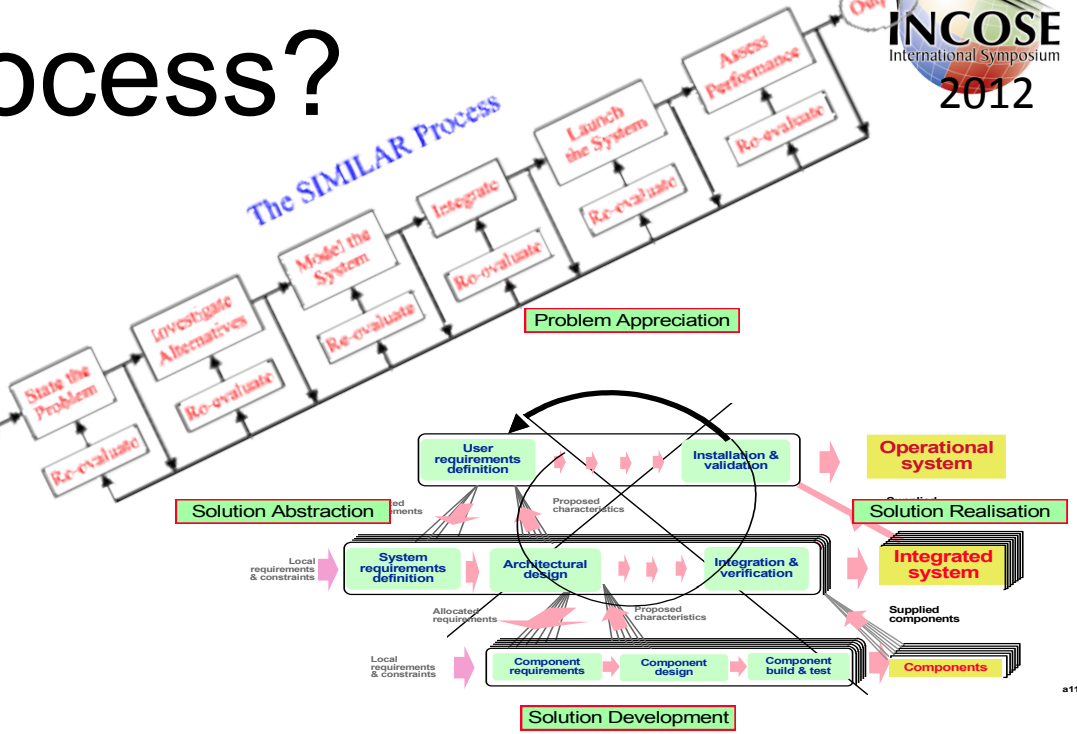
Seven camps in systems engineering

1. Life cycle
2. Process
3. Problem
4. [Meta-]Discipline
5. Domain
6. Systems thinking and non-systems thinking
7. Enabler

Discussed in Kasser and Hitchins 2011
Updated in the paper 2012

Which process?





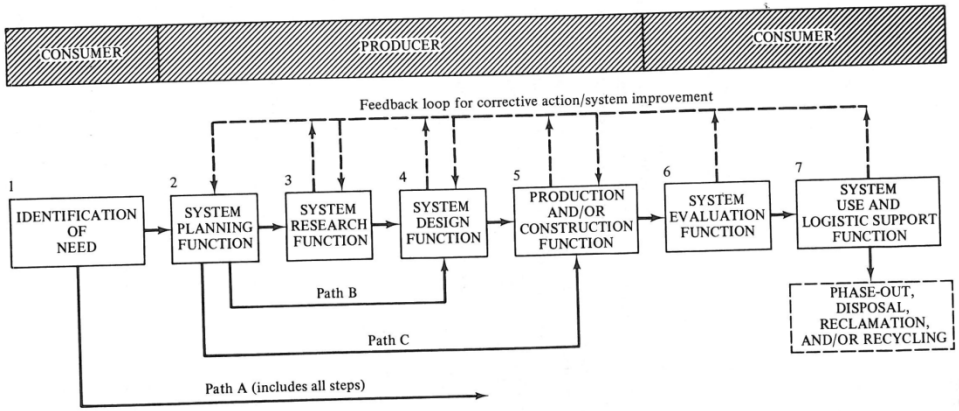
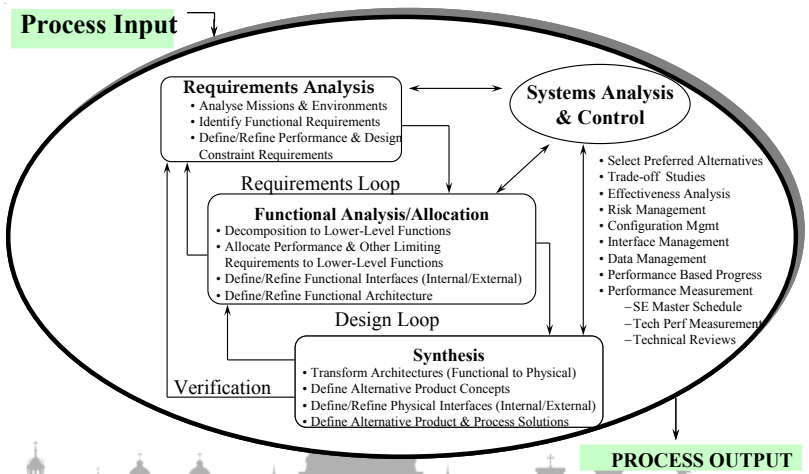
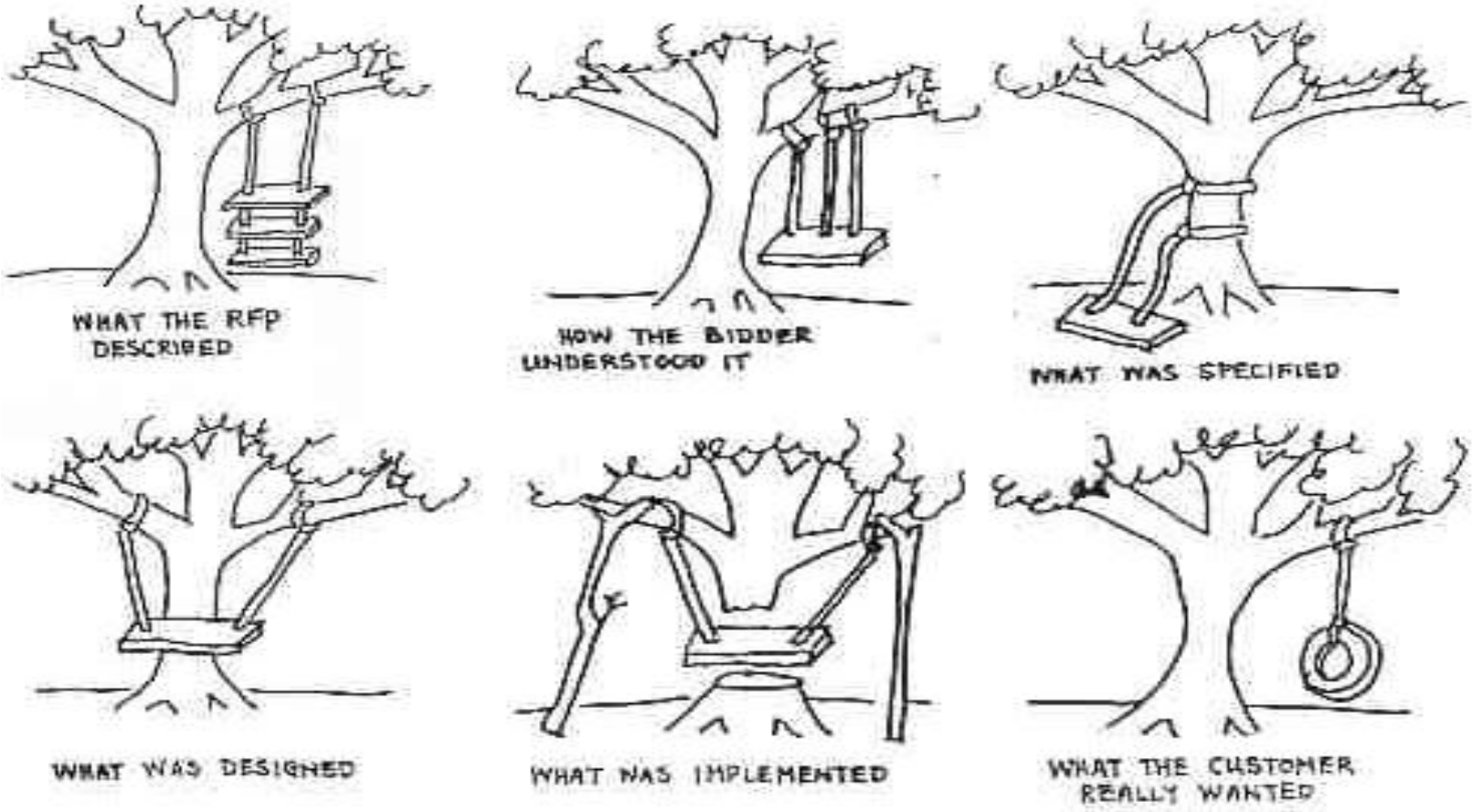


Figure 2.2. System-life-cycle functions.*

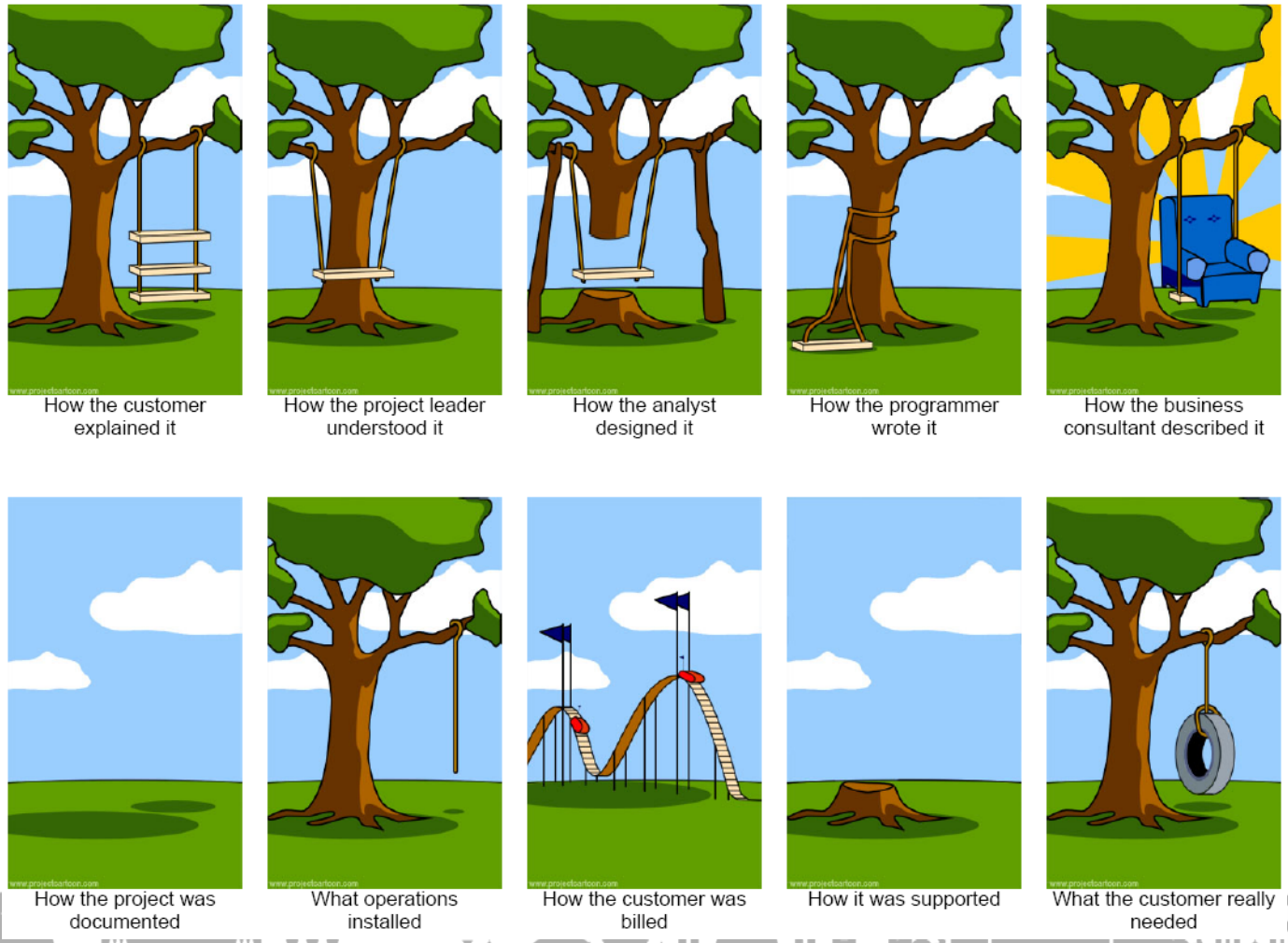


The systems engineering process (1970)

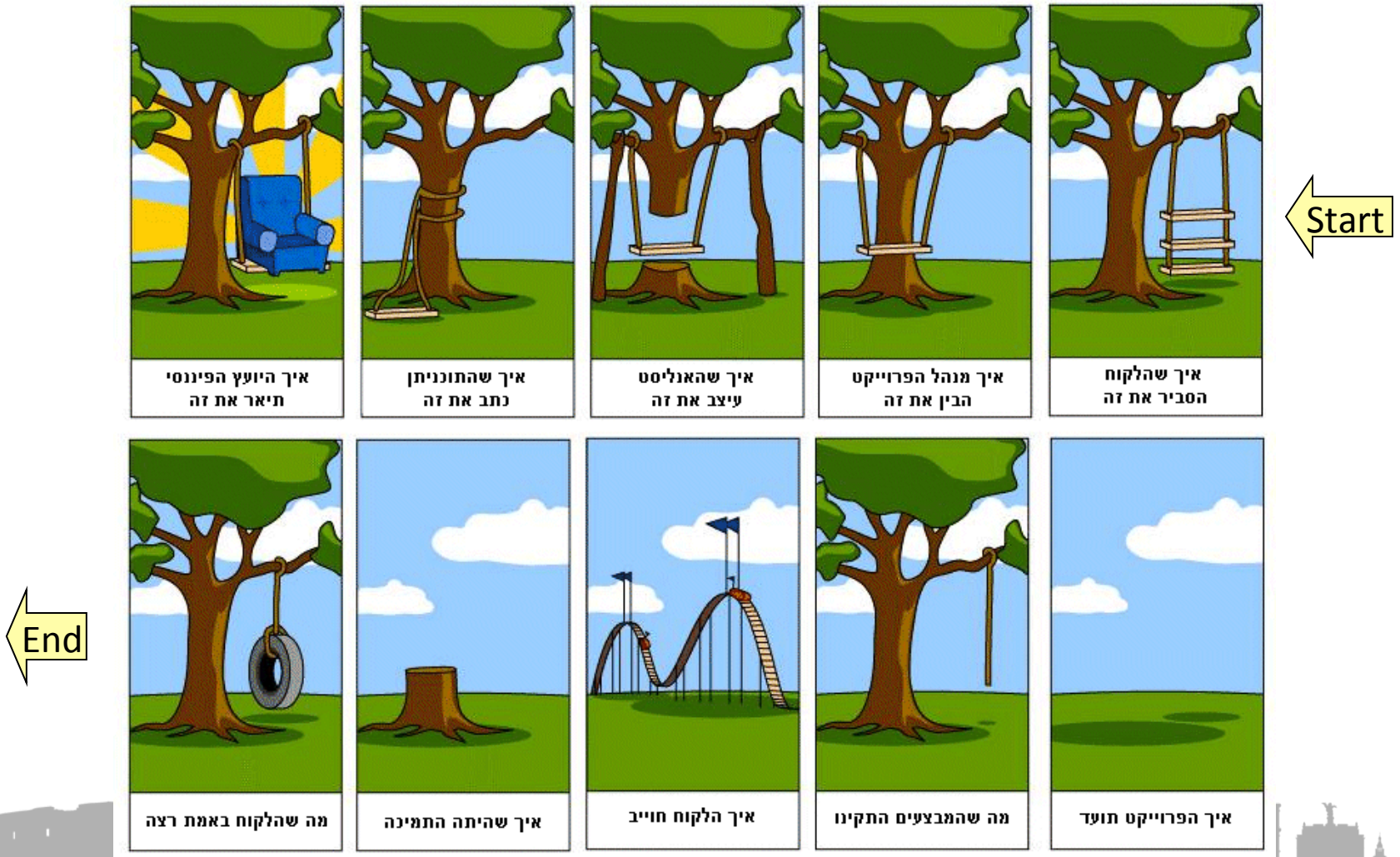


The systems engineering process (2010)

More steps



International process



The problem camp

Systems engineering "concentrates on the design and applications of the whole as distinct from the parts … looking at a problem in its *entirety*, taking into account all the facets and all the variables and relating the social to the technical."

(attributed to Simon Ramo, 1973)

The discipline camp

- Meta-discipline
- Multiple disciplines and domains
- Breadth and depth of knowledge
- T- shaped systems engineer

Enabler camp

- Systems engineering is
  - Is a philosophy and a way of life" (Hitchins, 1998).
  - The application of holistic thinking to:
    - see [missing] connections where others don't
    - develop an understanding of a situation
    - identify the real problem
    - identify an appropriate solution
    - plan the implementation of the solution
    - predict probable futures, risks and their mitigation.

Enabler camp

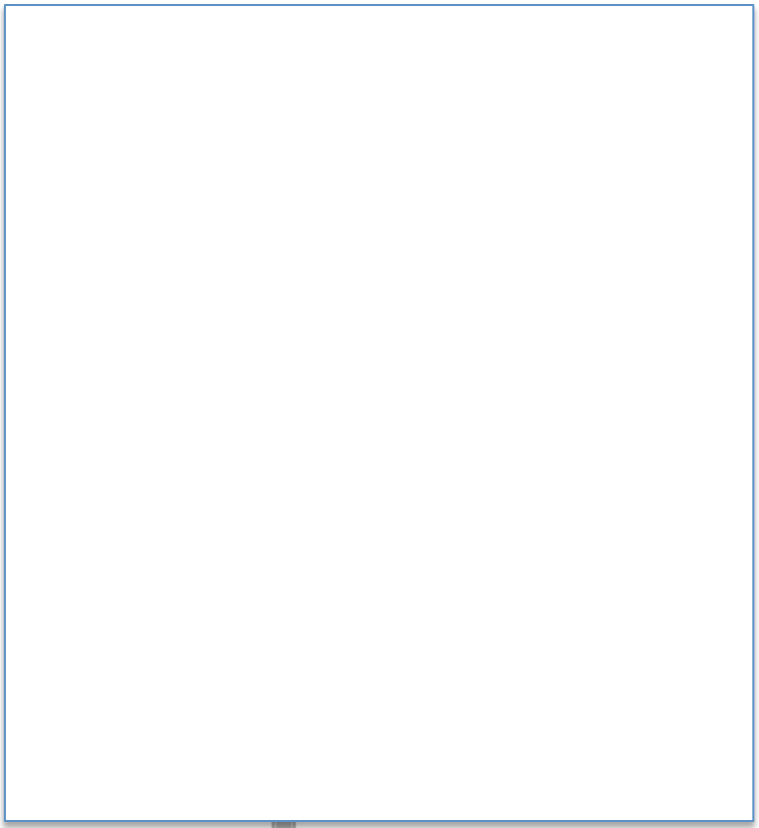
- Systems engineering is the "*engineering discipline governing the design, evaluation, and management of a complex set of interacting components to achieve a given purpose [function]*"
  - George Friedman,1996

Parable of blind men and elephant*

"…
And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

MORAL.

So oft in theologic wars,
The disputants, I ween,
Rail on in utter ignorance
Of what each other mean,
And prate about an Elephant
Not one of them has seen!"



* Yen, D. H., The Blind Men and the Elephant, 2008, http://www.noogenesis.com/pineapple/blind_men_elephant.html, last accessed 26 October 2010

Reconciling the camps

- SETR
  - systems engineering - the **role**
  - what systems engineers do in the workplace
  - Growing into Meta-discipline
  - Combination of SETA and non-SETA
  - Cannot be differentiated from other disciplines
- SETA
  - systems engineering - the **activity**
  - can be performed by anyone
    - SETA maps into SETR
  - Can be differentiated from other disciplines
    - See paper* for how SETA meets the requirements for being a discipline

* Kasser and Hitchins, 2012

Systems engineering paradigms*

- **SETR:** activities performed by personnel known as systems engineers.
  - Examples are network systems engineering, control system engineering, communications systems engineering, etc.
  - In many instances the type of system is dropped from the title.
  - **This systems engineering overlaps other disciplines and the exact role depends on the situation**
    - **Broad range of competencies**
- **SETA:** activities concerned with problem identification and solution realization at the system level
  - Kasser and Hitchins, 2009
  - **This systems engineering is an enabling discipline (like mathematics) for remedying undesirable situations**

* Kasser and Hitchins, 2012

SETA in Singapore: systems approach works*

- Social System
  - Public Housing
- Economic System
  - Industrial Development
- Defence System
  - Air Defence

Dr Goh Keng Swee (1918-2010)

- Minister
- Visionary
- Economist
- Systems Architect
- **one tool he used was Systems Engineering The Activity**

*LUI Pao Chuen, Singapore: An Example of Large Scale Systems Engineering, APSEC, 23 March 2007.

SETA

Modifying George Friedman's definition

- SETA may be considered as a "*discipline governing the design, evaluation, and management of a complex set of interacting components to achieve a given purpose [function]"* by the application of holistic thinking.
- SETA remedies George's undesirable situation, namely the lack of a GUTSE (grand unified theory of systems engineering)*

* George J. Friedman (Friedman, 2006) called for the development of a GUTSE echoing (Hill and Warfield, 1972) who wrote "*development of a theory of systems engineering that will be broadly accepted is much to be desired*." (Kasser, INCOSE, 2007)

SETA

- **Cooking a meal**
  - Meals emerge from both the process and the combination of, and the interaction between, the ingredients.
  - The best ingredients will not save a meal that was over-cooked or under-cooked.
- **Diagnosing an illness**
  - Good physicians consider the symptoms holistically in the context of the physiology of the patients and their environments.
- **Organising a conference**
  - Conference emerges from the combination of, and interaction between, the location, speakers, reviewers, delegates, and other entities.
- **Solving crimes**
  - Detectives, upon investigation, find a variety of clues which (should) lead to the perpetrator

Conclusion: SETA and SETR

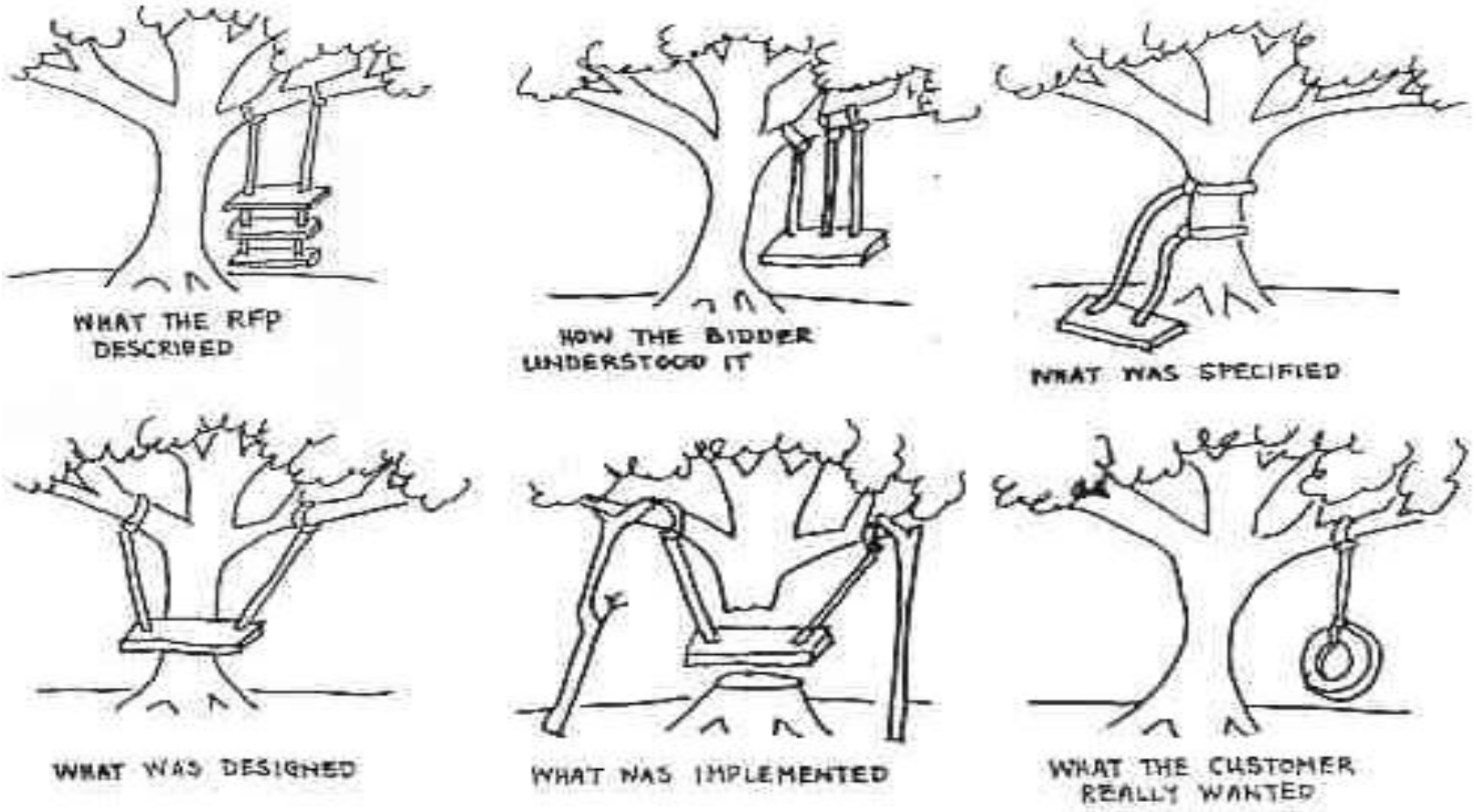
INCOSE International Symposium 2012

- Resolves the conflicts and contradictions in the current state of systems engineering
- The traditional activities known as systems engineering can be described in terms of SETA and SETR.
- SETR is the job title for a person who performs a mixture of SETA and non-SETA.
- SETA is an enabling discipline that is used in other disciplines and domains.
- SETA as a discipline can be differentiated from other disciplines.
- Resolves issues due to the overlap between systems engineering and project management.

Processes

- **No such thing as a Systems Engineering Process.** It is the
  - System Acquisition and Development Process
    - In which SETA takes place
  - System life cycle
    - In which SETA takes place
- Domain knowledge is critical for success
  - Problem, solution and implementation

The systems engineering process (1970)

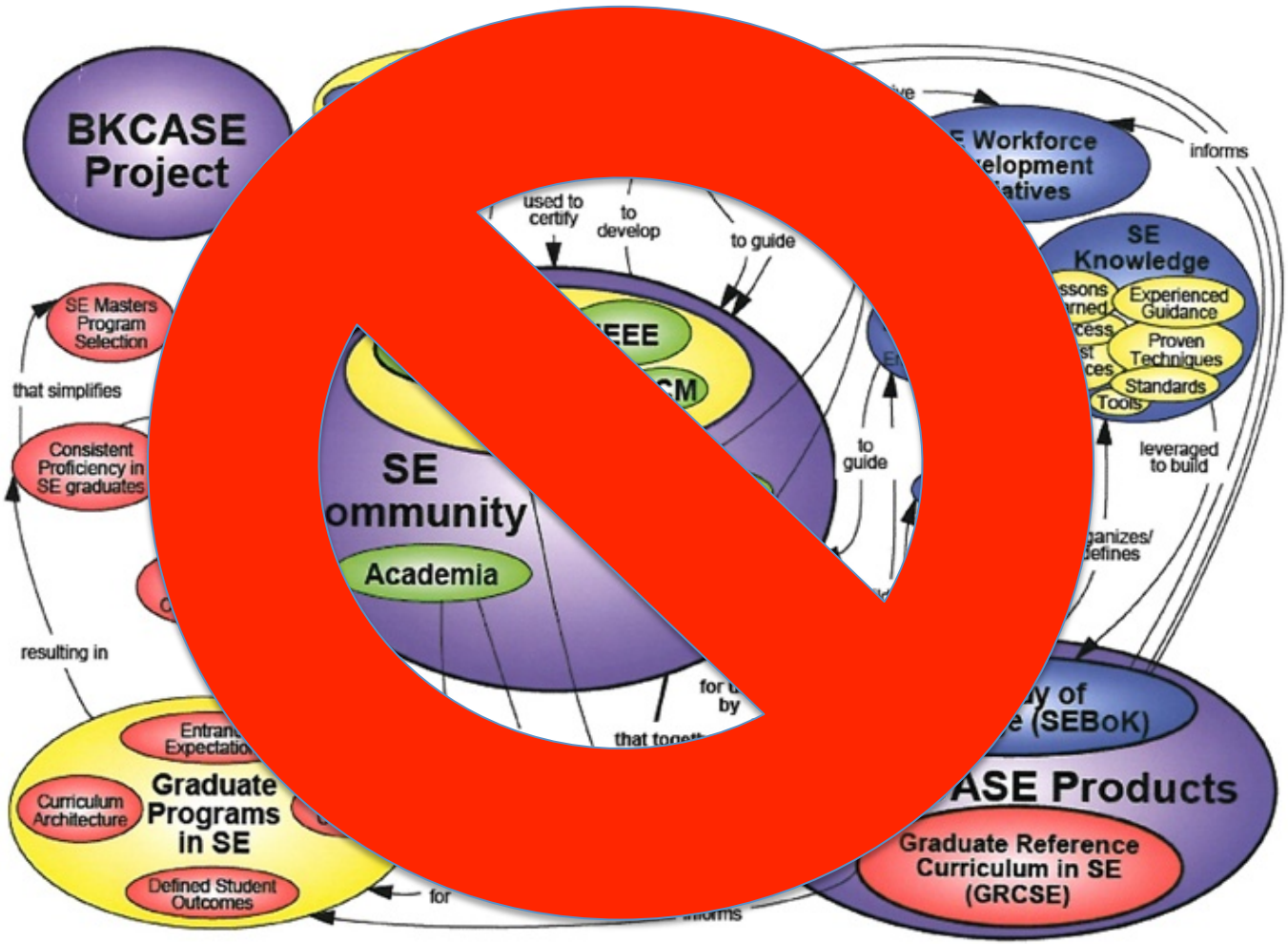


Lack of a common vision of the solution (Wednesday 1000)

SEBoK

- SETR
  - All disciplines that overlap systems engineering
  - All domains in which SETR is done
    - Approach rejected in Kasser and Massie, INCOSE, 2001
- SETA
  - Converting complexity to simplicity
  - Converting undesirable situations into desirable situations
    - Problem identification and remediation by the application of holistic thinking
      - systems thinking, analysis and critical thinking
  - A set of thinking tools used in addition to domain competency

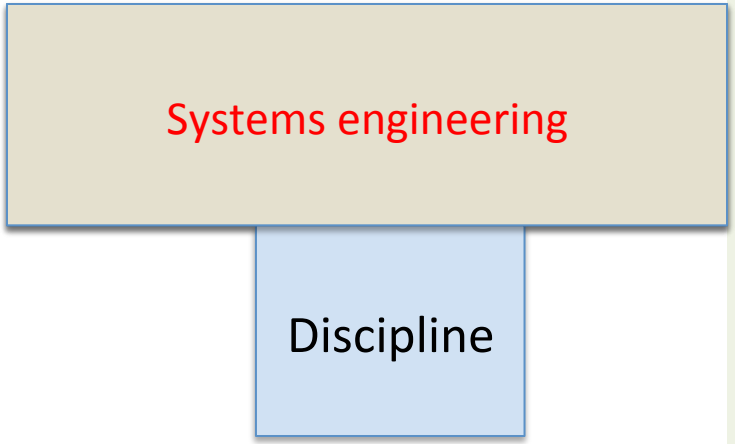
SETR: Building artificial complexity



Topics

- The undesirable situation
- Seven systems engineering camps
- Reconciling the camps
- SETR and SETA
- The systems engineering process
- Conclusions
- Simplifying the SEBoK
- **The ‘T’ shaped systems engineer**

The ’T’ shaped professional



- Research environment
- Deep knowledge of one domain
- Know how their disciplines interact with others

- People possessing these skills are
  - able to shape their knowledge to fit the problem at hand rather than insist that their problems appear in a particular, recognizable form
  - needed when problems cross domains
    - Dorothy Leonard-Barton (1995), *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*, Harvard Business School Press
      - Drawing is Figure 3.5

“Telephone” or Chinese whispers”

The ‘T’ shaped systems engineer

Questions and comments?

ice

requirements

- How deep?

- Change perspective
- Rotate the ‘T’ 90 degrees